# PROMOTING A CHILD FRIENDLY EDUCATION: MATHEMATICAL MODELING ACTIVITY AS A TOOL FOR MEANINGFUL LEARNING

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**Abstract**

Mathematics is one of the school subjects feared the most by the majority of students. This situation is caused by many factors, including: students' lack of interest and motivation, as well as the lack of understanding regarding the benefits of mathematics by the students. Mathematical modeling activity is one of teaching strategies that offer the solution for this situation. This strategy, as it manifests a real life connection to mathematics, allows meaningful learning so that learning becomes more realistic to the students. Meaningful learning in mathematical modeling can also develop learning interest and motivation as it engages students in the modeling process. This study briefly describe how mathematical modeling activity acts as a tool to meaningful learning. The discussion shows that mathematical modeling activity can improve students' motivation and interest so that it can promote a more child friendly education in school.

**Keywords**: mathematical modeling, meaningful learning, motivation, child friendly education

## INTRODUCTION

Every students has the right to quality education. A well-managed classroom is needed to facilitate students' learning and reduce disparities among students. To promote a more child friendly education, learning should be authentic and contextualized problems of study, and problem-solving that stresses skills development as well as knowledge acquisition. (Glatthorn & Jailall, 2000). Most importantly, in order to make a friendly environment for students to learn, students need to feel secure in their learning process. (UNICEF, 2000).

However, it unlikely happens in mathematics teaching and learning practices. If students were asked a question, "What is mathematics to you?", perhaps the answers are mostly stated that mathematics is like a monster. They fear and hesitate to learn it further. There are also many students who complain that mathematics is a boring subject and has no real life application.

Among the causes of students' fear and boredom are difficulty in understanding mathematical problems, and students' lack of understanding in the benefits of mathematics in every day life (Santilan, et al., 2005). This situation can be overcome by implementing teaching strategies that encourage students' in understanding the benefit of mathematics in real life. Appopriate teaching strategies are also able to increase students' interest and motivation towards learning mathematics. Among various teaching strategies, mathematical modeling activity is a strategy that offer the solution of these problems.

Mathematical modeling is strongly related to the tranformation of real life situation to mathematics. It is applied from every observable phenomena including natural science, social science, and any disciplines other than mathematics (Blum and Ferri, 2009; Pollak, 1979). Mathematical modeling activity does not only facilitate students to understand the world better, but it also encourages students' mathematical learning activity by forming, understanding, and mastering mathematical concepts in order to develop mathematical competencies. It makes a more realistic understanding of mathematical concepts and creates a more meaningful learning for the students. (Blum and Ferri, 2009). As stated by Ausebel (1963), "*The most important single factor influencing learning is what the learner already knows*". Meaningful learning is when students are able to relate new situations with their known mathematical concepts.

A classroom management with meaningful learning allows students to enjoy themselves while learning. Students are also motivated, like carrying out their work, hand their materials in and are pleased with their educational experience (Vallori, 2014). Furthermore, Novak (2010) stated that meaningful learning encourages students to integrate known concepts with new relevant situation based on their cognitive structure. Students are in charge of their learning process and able to utilize the knowledge to solve the problems. The engagement and control of the students in their learning process is strongly related to their interest in learning mathematics. This situation influences to motivations to learn and impacts on students' mathematical competencies as well.

This asumption is supported by the result of an experiment done by Schukajlow, et al. (2012). It

is stated that mathematical modeling activities have positive effects in students' enjoyment, interest, value and self efficacy which goes up significantly. By implementing mathematical modeling activities, there was an increase in positive attitude of students, especially the students 'learning motivation, which in turn has an effect on improving students' mathematical ability and learning outcomes.

The aim of this study is to describe students' interest and motivation treated with two modeling tasks. We focus on students' perceptions regarding mathematics and its application in real life. By describing students perceptions, we intent to relate students' interest and motivation to promote a more child friendly education in school.

## RESEARCH METHOD

This qualitative study was caried out in SMK Muhammadiyah 1 Wedi, a private vocational school in Klaten, Central Java. A number of 18 students aged 15-17 years old which are not familiar with mathematical modeling tasks were observed. The names of the students then were coded to S-1, S-2, ...., S-18.

Before working on the tasks, the students were given checklists which portrays their general perceptions on their interests and motivations in studying mathematics. After collecting data of the initial perceptions, we instructed the students to formed 4 groups consist of 4-5 students. The selection of the group members were based on students' individual choices and we supported students' individual preferences.

The students were given two modeling tasks and asked to solve the modeling tasks collaborately with their group members. As a thought revealing activity, problems given in modeling tasks should be relatable to the students, so that they are able to imagine the problem situations well. Modified from Blum and Ferri (2009), the open-ended and authentic tasks were designed so that students' interest and motivation in solving the problems would increase. The given tasks are shown below:

**Task 1**

**Pengajian Tarjih**

*Akan diadakan sebuah pengajian tarjih di Masjid Al-Aqsa Klaten. Salah satu takmir Masjid Al-Aqsa ingin mengestimasi banyak jama'ah "minimum" yang dapat ditampung masjid. Jika ternyata daerah masjid yang bisa digunakan hanya 2.500 $m^2$, menurutmu, berapa estimasi banyak jama'ah di dalam Masjid Al-Aqsa? Diskusikan langkah-langkah penyelesaian secara matematika dengan kelompokmu.*

Translated to English, it would be:

**Pengajian Tarjih**

*There will be pengajian tarjih in Masjid Al-Aqsa Klaten. One of the takmir wants to estimate minimum people that can attend the event inside the masjid. However, the area of the masjid that can be used is only 2.500 $m^2$. Based on your group's opinion, how many people attending the event inside Masjid Al-Aqsa? Discuss the steps on solving this problem mathematically with your group members.*

Masjid Al-Aqsa is a new landmark in Klaten. Therefore, it is familiar and realistic to the students. However, the task above only include one given measurement needed, that is the area of the masjid. Students need to look for other required data and conditions by themselves. They also need to discuss appropriate measurements which can be gathered from several sources by asking their friends and teacher, or browsing through the internet.

**Task 2**


**Kuota Internet**

*Kuota internetmu sudah habis. Terdapat sebuah konter pulsa, "Squidward Cell" yang letaknya tidak jauh dari rumahmu, hanya sekitar 1 km. Sayangnya, harga kuota di konter tersebut terbilang mahal dibandingkan 2 konter lainnya, dengan selisih yang hampir Rp8.000,00. Dua konter yang lain yang dimaksud adalah "Sponge Bob Cell" dan "Patrick Cell". Teman-temanmu sudah tahu bahwa jarak*

*"Patrick Cell" dan "SpongeBob Cell" adalah sekitar 2 km. Harga kuota di "Patrick Cell" biasanya lebih murah Rp2.000,00 – Rp5.000,00 dari "SpongeBob Cell".*

*Konter mana yang akan kamu pilih? Mengapa kamu memilih konter tersebut? Diskusikan langkah pemilihan konter dengan kelompokmu. Tuliskan syarat pemilihan konter tersebut dalam bentuk matematika.*

Translated to English, it would be:


**Internet Quota**

*Your internet quota has run out. There is a counter, called "Squidward Cell" which is located near to your house, about 1 km. Unfortunately, it is quite pricey compared to another 2 counters, with almost Rp8.000,00 difference. Those 2 counters, are "Sponge Bob Cell" and "Patrick Cell". Your friends have already known that the distance of "Patrick Cell" and "SpongeBob Cell" is about 2 km. Based on your friends' experiences, the prices in "Patrick Cell" are far cheaper Rp2.000,00 – Rp5.000,00 than"SpongeBob Cell".*

*Which counter would you choose? Why do you choose that counter? Discuss the steps on solving this problem with your friends. Write down the conditions needed in choosing the counter mathematically.*

It is common for students to buy internet quota by themselves. Therefore, Task 2 is also relatable to students' as it happens in their every day lives. As what it states before, students need to find any other measurements and conditions in order to solve the problem. However, in contrast to Task 1, Task 2 required the students to explain their solution. It also required the students to find their own rules as it does not rely on a given formula.

Students' behaviour while solving the problems and delivering their solution in class was observed. The students were also asked to reflect on their modeling activity. In the end, a wrapped out discussion was conducted to discover students' perceptions on their interests and motivations after given mathematical modeling tasks

## RESULT AND DISCUSSION

Students' pre-mathematical modeling activity confirms that mathematics was considered as a boring subject by 56% of the students. Another 11% of students think that mathematics is one subject considered as scary, and the rest 33% of students think that mathematics is a joyful subject learned at school. In regards to the benefits of mathematics in real life, 61% of the students has thought that mathematics is not entirely related with their every day lives, while 39% of the students agree with the idea of the benefits of mathematics in real life. As they are students in a vocational school focused in accounting, 67% of the students agree that any economic activity is the one which best represents the applications of mathematics in real life while the rest 33% of students believe to the applications of mathematics in a broader term.

Furthermore, based on pre-mathematical modeling activity, most of the students thought that mathematical rules and formulas should be memorized in the first place. The students believe that remembering the rules and memorizing the formulas could help them solving mathematical problems given by the teachers. This statement is not false, however, it has to be emphasized that learning is not about memorizing the formulas and remembering the rules or procedures. Students need to know the meaning of the rules and formulas before applying them to solve given tasks by the teachers. However, based on the students' opinion, most of them do not understand the origin of the formula utilized to solve the problems.Therefore, in order to promote a more meaningful learning, two mathematical modeling tasks were given to the students. One characteristic of modeling tasks is that students have to look for appropiate mathematical concepts to solve the given tasks. The students have to transform real life situations to mathematical explanations and explain the result using their own explanations as well.

During mathematical modeling activity of Task 1, we observe that students generally focus on the given numbers and known mathematical formulas. However, at the problem solving process, students are able to integrate the given situation with their already known concepts. Here is an example of group 2 discussion:

S-6 : Hmm.. if we are asked to find the minimum people attending *pengajian tarjih*, what should we find first? Any idea?
S-5 : I don't know, perhaps we should look at the given data first? What is already known?
S-8 : Masjid Al-Aqsa is huge.
S-5 : Of course, it is huge. I mean, is there any number that we can use to solve the problem?

S-6 : I am wondering it too. How about formulas? Is there any formula that can solve this problem?
S-7 : It is said that the area of the masjid that can be used is only 2.500 $m^2$. I don't know, what can we do with this number? It is not that Masjid Al-Aqsa is just a square. We can't directly take a root of 2.500 $m^2$.
S-5 : No, root of 2.500 is 50. What does 50 stand for? Isn't it non sense?
S-6 : It is non sense enough. Hmm, fifty? what fifty? Fifty person?
S-5 : No, it is unlikely that huge masjid can only be attended by 50 people. I think it will go like this. We need to find the number of minimal person that could attend the event. So, it is the quantity of the person. If there is a given area of masjid, we need to find familiar measurement, like.... like what, anyone?
S-6 : The area of a person?
S-7 : Ah, yes, correct. How to measure it?
S-8 : (*Strecthing out her arms*) How long is this?
S-6 : That would be too long. Isn't it easier if we use floor tiles? I think we can try sitting on the floor to estimate the area. Who wants to sit on the floor?
S-8 : I'll do it. (*Immediately sitting on the floor*).
S-6 : Looking at the floor tiles, I think a person would cover the area of 60 cm or 0,6 m, 60 cm x 60 cm?
S-8 : If we assumed the area covered by people who is sitting is square, then, is it 3.600 $cm^2$?
S-6 : Yes, that would make it.
S-5 : Fine, let's use this measurement.

The above dialog shows how students in group 2 interacted with each other. Group 2 solution can be seen on Figure 1.

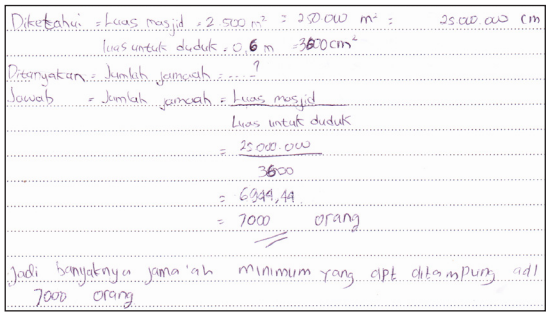


Figure 1. Group 2 Solution on Task 1

The students generally utilized their known mathematical concept, that is the concept of square's area, to solve Task 1. It is true that the concept applied to Task 1 had already been learned by the students in their previous time learning in junior high school. However, the application of the concept in a more realistic term of their every day lives is the focus of this modeling activity. Task 1 is an open-ended task, therefore, multiple solutions are most likely encouraged. Encouraging multipe solutions is a form of respecting individual differences, one principal of a child friendly education.

Task 2 required a deeper understanding of the problem. For a moment, students were distracted by this problem. As noticed by the students, there is no formula that can be utilized in solving the problems. Therefore, according to Blum (2011) and Leiß (2007) in Ferri (2018), teacher intervention is needed to keep the students on track. In this case, teacher needs to intervene students by saying "*Actually, there is no wrong answer as long as your explanation is on point. You can use your own language, and perhaps your own formulas or rules to solve the problem. You can start it with drawing the situation on your worksheets*."

With the help of teacher intervention, we observed that students are able to draw the situation based on their understanding. Some examples of the drawing are shown on Figure 2 and Figure 3.

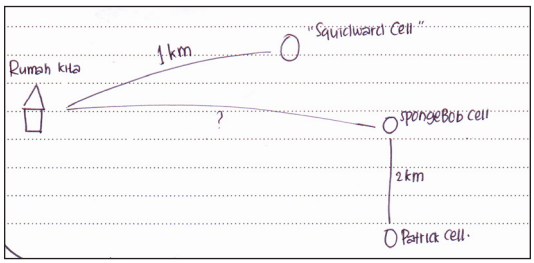


Figure 2. The drawing of group 1 on Task 2

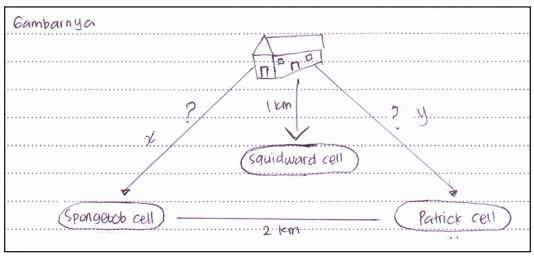


Figure 3. The drawing of group 3 on Task 2

As a consequence, students' multiple soutions is highly encouraged in Task 2. An example of the solution is shown in Figure 4.

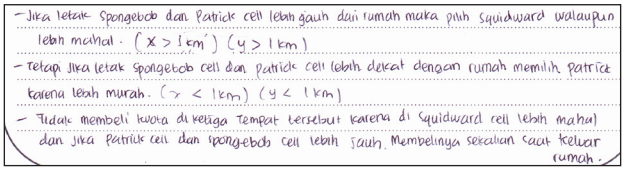


Figure 4. Group 3 solution on Task 2

Based on the Task 2 solution above, the students do not use known formulas in solving the

problem. The most important aspect of this activity is that students can explain their thinking and understand that mathematics is beyond remembering rules and memorizing formulas. Students were also use mathematical symbols to explain their solution. In case of group 3 solution above, the students use simple mathematics symbols to explain their solution. The first condition of group 3 solution is that if $x > 1$ km and $y > 1$ km, therefore they chose *Squidward Cell*. The second condition is that if $x < 1$ km and $y < 1$ km, therefore they chose *Patrick Cell* because it is cheaper. Lastly, they chose not to buy in any of those 3 counters if the previous 2 conditions was not met.

The solution is indeed simple. However, the example of simple solution done by students shows that students were able to relate what they had done to the new situation in their everyday lives. We argue that this attitude is a sign of a more meaningful learning by the students.

Lastly, after being given two mathematical modeling tasks, we conducted a focus group discussion in order to understand students' perceptions towards the benefits of mathematics and its application in real life.

We found that according to S-3 and S-4, tasks that are not always relied on the ability to memorize formulas are more favored. In contrast to this situation, some students stated that modeling tasks need longer time to be understood compared to routine tasks given in everyday learning process. S-10, S-15 and S-16 stated that modeling tasks are complicated and need assumptions in order to solve the them. However, the majority of the students stated that solving these interesting and realistic tasks are enjoyable. As the tasks are interesting and authentic for them, the majority of the students stated that at the they are more happy and feel engaged in the process. "*It's like solving puzzles and I feel satisfied at the end of the problem solving process. Mathematics is challenging*," as stated by S-11. S-8 also stated, "*I want to learn mathematics further, so that I can solve any problems in my life.*"

More importantly, students become more aware of the application of mathematics in real life. "*After working on these problems, I think mathematics is not about formulas and theories. It is strongly related to our every day life. Task 1 and Task 2 are examples of it*," stated by S-11. S-3 added, "*Mathematical tasks should be derived from our every day life. It needs reasoning, not memorizing formulas which stress me up.*"

Based on the focus group discussion done after the modeling activity, it can be noted that the tasks given in modeling activity influenced the students to become more interested and motivated in solving the problems. The enjoyment and engagement show that students motivation to learn and positive perceptions towards mathematics have increased.

## CONCLUSION AND SUGGESTION

The goal of this study is to lead students to think, "*Mathematics is not scary, it is challenging,*" or "*Mathematics is not boring, it is fun*."

Based on the results of this study, mathematical modeling encourages positive attitudes towards mathematics. Compared to pre-mathematical modeling activity, students' perception, including interest and motivation had increased. The implementation of mathematical modeling activity in teaching and learning process at school should supported in order to maintain students' interest and motivation in learning mathematics.

An appopriate mathematical modeling activity also created a joyful atmosphere which influenced students' engagement in the problem solving process. As joyful atmosphere make a more secured place for students to learn, therefore it can be concluded that mathematical modeling activity is able to promote a more child friendly education in school.

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